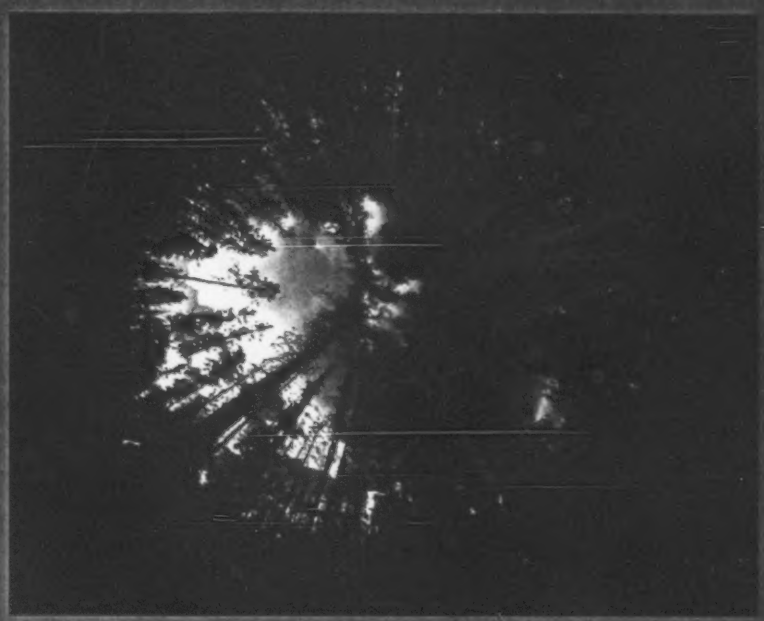
TECHNICAL REPORT 046

A Framework for Documenting the Effects of the Mountain Pine Beetle Outbreak in Sub-boreal Forests of Northern British Columbia (E.P. 1369): Establishment Report



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A Framework for Documenting the Effects of the Mountain Pine Beetle Outbreak in Sub-boreal Forests of Northern British Columbia (E.P. 1369): Establishment Report

Ben Heemskerk, Craig DeLong, and Tanya Milner

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ABSTRACT

This report outlines the objectives, study design, methods of data collection, and other details relevant to the establishment of Experimental Project (EP) 1369: A Framework for Documenting the Effects of the Mountain Pine Beetle in Sub-boreal Forests of Northern British Columbia. In 1995 through 1997, 48 plots were established in mature pine leading stands affected by mountain pine beetle (MPB) (38 plots) and MPB followed by wildfire (10 plots). All plots will remain unharvested, and are designed to examine ecological changes subsequent to these disturbances. The information from these plots will inform science on what ecological changes result from these disturbances in the sub-boreal forest landscape, and will provide critical information (such as growth rate of live understorey) to land managers.

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The mountain pine beetle (MPB) outbreak currently spans more than 7 million ha in British Columbia, of which approximately 30% is expected never to be salvaged. For this land, the Chief Forester assumes a 20-year delay in regeneration, which is one of the considerations in forecasting a fall-down in timber supply approximately 15 years hence (B.C. Ministry of Forests 2003). This estimate was based on a small sample of stands and expert opinion. To accurately predict the loss in timber yield from unsalvaged stands, data are required from a valid probability sample. It is critical to accurately estimate future timber supply in MPB-affected areas so that appropriate measures can be taken to estimate and mitigate the fall-down. This outbreak offers the opportunity to examine the ecological, social, and economic benefits and tradeoffs of three potential management options: (1) no interference; (2) the use of prescribed burning; and (3) conventional timber harvesting.

Based on recent studies (Coates et al., B.C. Ministry of Forests and Range, unpublished data) there is a wide range in the amount and distribution of live understorey trees in MPB-affected stands. Understanding how this understorey responds to the increasing light levels associated with the mortality of the overstorey is critical for predicting the future role of these stands in meeting mid- and longer-term timber supply needs.

Large areas of the Northern Interior landscape can or will be left unmanaged with little appreciation of their impact, positive or negative, on forest values. In addition, wildfires burned tens of thousands of hectares of beetle-killed timber in 2004. It has been noted that pine cones were completely consumed in some areas, and it is uncertain how well these areas will naturally regenerate.

Forest plans call for the deferral of harvesting in old-growth management areas, wildlife tree patches, and riparian buffers, but the ability of beetle-killed stands to provide the desired habitat biodiversity remains unknown. Consequently, all aspects of forest planning and the prospects for sustainable forest management in much of the Northern Interior are a matter of speculation. Some critical decisions must be made on where to strategically leave unsalvaged stands for meeting land stewardship goals. Data are needed on the relative habitat value of different stand types affected by MPB.

Long-term monitoring of stands is the most precise method of describing structural and compositional changes over time and can provide information over both short and long timeframes. While chronosequence or "space-for-time substitution" studies can elucidate broad trends, such cross-sectional studies cannot reliably substitute for longitudinal studies in exposing the mechanisms at play (Pickett 1989). The added (and usually unattributed) variance of site and site history differences make chronosequence approaches open to criticism (Fleming 1999). Short-term approaches cannot substitute completely for direct long-term observations of ecological phenomena (Franklin 1989). This is especially true when dealing with slow processes (e.g., plant succession), the impact of rare events (e.g., killing frosts), episodic phenomena (e.g., windthrow), processes with high variability, and an array of subtle processes and complex phenomena that require long-term studies to separate pattern from "noise" (Franklin 1989; Pickett 1989).

A number of studies have collected information similar to that for this project. The drawbacks of these studies are: they do not cover mesic sites in any other biogeoclimatic unit than the SBSdk, they were not randomly selected (so inferences from these plots across the landscape are inappropriate), and data such as functional wildlife tree type and natural regeneration ingress were not collected. They are also one-time measurement plots with no remeasurement intended. Data from these plots will be useful to compare to certain data from our plots, but we will not rely on data from these plots to satisfy our objectives due to the aforementioned limitations.

Data from this system of randomly located permanent sample plots will provide scientifically irrefutable answers to a wide range of questions relating to MPB stand and ecosystem dynamics. This study was set up to establish a multi-purpose monitoring framework for facilitating the efficient evaluation and reporting of stand-level attributes and consequences of the outbreak. The data collected from this project will provide a much-needed understanding of: (1) ecological changes and value of unique stand features (e.g., wildlife trees) of unsalvaged and burned unsalvaged MPB stands; (2) forest regeneration and non-crop vegetation dynamics of unmanaged and burned MPB stands; (3) timber supply (regeneration delay, growth and yield) and biodiversity implications of unharvested MPB stands; (4) relative ecological and economic (timber supply) benefits of burning unharvested MPB stands; (5) windthrow and decomposition dynamics of pine trees killed by MPB; and (6) changes in lichen abundance and rate of tree fall, as they affect caribou habitat quality.

2 OBJECTIVES

In determining ecosystem changes over time in response to MPB, the study objectives are divided into short-term (1–3 years) and long-term objectives. The overarching themes of the objectives are the tree mortality, regeneration establishment and release, changes in wildlife habitat value, and ecological succession.

2.1 Short-term objectives

- To initialize, parameterize, and test models to predict advanced regeneration growth and yield for unharvested MPB-killed pine stands (i.e., SORTIE-BC, TASS);
- To describe the extent of natural regeneration for MPB-killed stands and to ascertain the effect of wildfire on tree recruitment rates;
- To determine average mortality rates of lodgepole pine by age/diameter class, and to monitor understorey release;
- To evaluate the "old-growth habitat value" of unsalvaged MPB stands by comparing functional habitat characteristics (e.g., number and type of Wildlife Tree and CWD Types [Keisker 2000]) to data previously collected in old-growth stands (MacKillop and Holt 2004); and
- To use models being developed by the University of British Columbia and the University of Northern British Columbia to determine initial snag fall rates and relate to wind events.

2.2 Long-term objectives

- To develop tree recruitment rates by refining growth and yield projections of advanced regeneration;
- To examine and compare forest and vegetation succession patterns for salvaged MPB stands, for MPB stands that remain unsalvaged, and those that are unsalvaged and burned;
- To characterize changes in habitat values associated with CWD and wildlife trees with time;
- To parameterize existing deadwood models (e.g., DeLong et al. 2004) for MPB stands;
- To augment lichen succession work by Williston and Chichowski; and
- To determine longer-term tree falldown rates and relate this to animal movement.

3 EXPERIMENTAL DESIGN

3.1 Definition of terms

Coarse Woody Debris (CWD) CWD includes logs and rooted trunks at an angle of < 45° with the ground surface, stumps < 1.3 m in height, large detached branches and slabs, large exposed roots, and upturned root masses. Taller stumps and more upright logs and rooted trunks are considered Wildlife Trees (Keisker 2000).

Decay Classes Decay Classes are the nine classes of the B.C. Wildlife Tree Classification System (Wildlife Tree Committee of British Columbia 2005).

Tree Species Tree species considered: hybrid white spruce (*Picea glauca* × *engelmannii*), black spruce (*Picea mariana*), subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta* var. *latifolia*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), and Douglas-fir (*Pseudotsuga menziesii*).

Wildlife Tree (WT) A Wildlife Tree is defined as a standing dead or live tree > 1.3 m in height, with special characteristics that are valuable for wildlife and that distinguish the tree from most other trees in the forest. Wildlife Tree Types (WTTs) and Coarse Woody Debris Types (CWDTs) are trees with specific attributes of value to habitat, and are described by Keisker (2000).

3.2 Plot locations

Permanent sample plots were established in severely attacked stands (< 70% attack) that were pine leading within the Sub-Boreal Spruce (SBS) zone (Meidinger and Pojar 1991) of the Vanderhoof Forest District (Figure 1). Two- to five-hectare buffers were marked using blue paint and red flagging tape printed with either "Growth and Yield" or "Research." These buffers will maintain plot integrity and provide enough space for destructive sampling and future research. Most plots have signs indicating "Forest Research Plot, Results will guide Forest and Range Management, Do Not Disturb," and contact information for the project on the buffer perimeter. During future measurements and plot maintenance the rest of these signs will be installed in a similar manner. Co-operation from licensee partners has been obtained to ensure that sites will not be salvaged and will be maintained as wildlife tree patches for a minimum of one rotation (80 years). The sites represent both

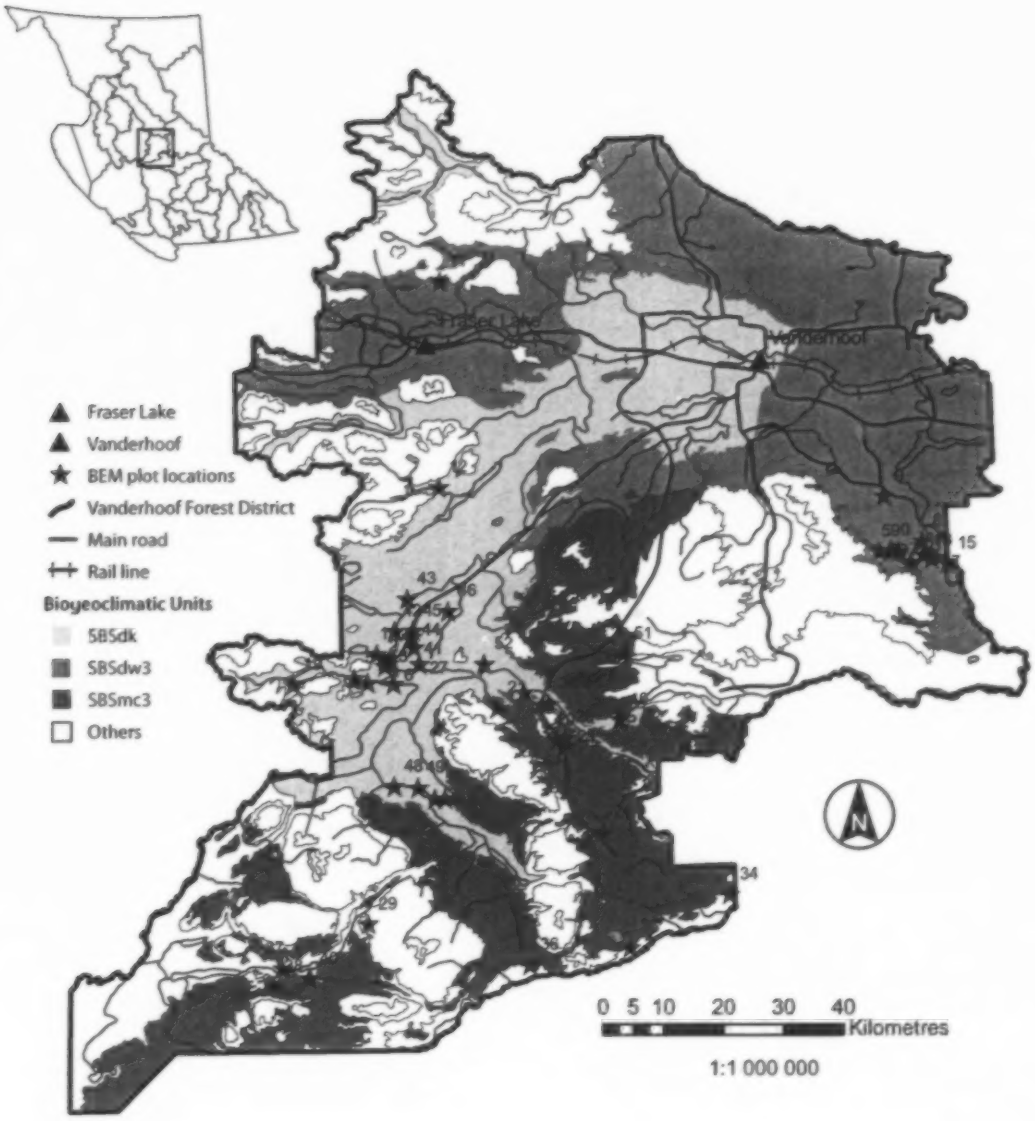


FIGURE 1 *Small-scale map of the plot locations within the Vanderhoof Forest District.*

cooler, moister conditions and warmer, drier conditions. Sampled sites include circum-mesic sites (01 site series) in the dry cool subzone of the SBS (SBSdk), the Kluskus variant of the moist cold SBS (SBSmc3), and the Stuart variant of the dry warm SBS (SBSdw3) (DeLong et al. 1993). In this manner, trends can be used to extrapolate responses expected under climate change.

Over two of the biogeoclimatic (BGC) units, dry (subxeric moisture regime) Pl – lichen sites were sampled based on availability. Plots were also established in a large fire that occurred in the Vanderhoof District in the

summer of 2004 within the SBSdk. The lodgepole pine stands within the boundaries of this fire were attacked by MPB prior to the fire. A total of 48 plots (Table 1; Appendix 1) from a target of 50 had been established by August 2007, with two Pl – lichen sites yet to be established. Suitable Pl – lichen sites have proved a challenge to locate; to date, 30 possible locations have been examined (during office or field reconnaissance), yet only eight suitable locations have been identified. During the summer of 2006 one established plot was determined to be unsuitable, and another was inadvertently logged. These plots have subsequently been replaced.

TABLE 1 *Distribution of sample sites across stand types in Vanderhoof Forest District*

Stand type	Biogeoclimatic unit(s)	Moisture regime	Target sample size	Actual sample size
Pl leading, MPB red attack, unharvested	SBSdk, SBSdw3, SBSmc3	Mesic	30 (10 in each BGC unit)	28
Pl leading, MPB red attack, unharvested	SBSdk or SBSdw3 or SBSmc3	Subxeric Pl - Lichen	10	8
Pl leading, MPB red attack, burned, unharvested	SBSdk, SBSdw2	Mesic	10	10

3.3 Plot selection

Plot location selection utilized information from the previously funded Mountain Pine Beetle Initiative project, "Plan for Establishment of Long-term Monitoring Plots in Mountain Pine Beetle Killed Stands." Available spatial data in a geographic information system (GIS) were used to select forest stands with the desired characteristics (Table 1). GIS data available from the Integrated Land Management Bureau were incorporated, and included current information on harvesting, relative beetle attack, stand type, large burns that occurred in 2004, and BGC site series. From the list of qualified sites, twice the number of required sample stands were randomly selected for final selection of plots (Table 1). Final plot selection was determined in the field based on the plot's ability to ensure long-term security, access (i.e., within 2 km of a road or available boat access), and suitability based on site visitation (i.e., some polygons lacked the mapped attributes). Most final plot selection was carried out by a contractor in the spring of 2005, and the remaining plot selection was completed during the summers of 2005 through 2007 by Ministry of Forests and Range staff.

3.4 Installation layout

Near the centre of the 2- to 5- ha reserves established for each plot, baseline measurements in a number of circular plots were taken, including: (1) stand structure measurements (height, dbh, live crown ratio), following Resource Inventory Committee (RIC) standards (each tree identified with numbered aluminum or plastic tags); (2) identification of functional wildlife habitat provided by trees (live and dead) and CWD (as developed by Keisker 2000); (3) a complete vegetation assessment according to RIC standards, with specialized modifications; and (4) regeneration assessment for all trees not included in the stand structure assessment.

The plot installations generally follow the Resource Information Standards Committee Vegetation Resources Inventory (VRI) procedures for establishing Change Monitoring Inventory (CMI) ground sample plots (B.C. Ministry of Sustainable Resource Management 2002). Establishment of an integrated plot centre, which is permanently marked with a metal stake, followed CMI standards (Figure 2). For all trees > 7.5 cm dbh, a central 11.28 m radius (0.04 ha) plot was used.

For advanced regeneration (> 30 cm height and ≤ 7.5 cm dbh), a 5.64 m radius (0.01 ha) plot was nested within the 11.28 m radius plot (Figure 2). For small advanced regeneration and seedlings (i.e., < 30 cm height), four 1.26 m radius (0.002 ha) plots were established. These plots are located at the end of four 15 m transects (i.e., outside of the central 11.28 m plot, in order to reduce trampling effects) (Figure 2). The first transect was established by adding 45° to CWD transect 1, then 90° was added to the previous 1.26-m transect bearing to determine the bearing for subsequent plot locations. This offset of CWD transects and 1.26-m plot (Figure 2) locations further reduced trampling effects.

A modified CMI sampling protocol was adopted for CWD, Small Woody Debris (SWD), and Fine Woody Debris (FWD) sampling. Two 30-m transects, one at a random bearing and the other at + 90° to the first from the integrated plot centre (Figure 2), were established. Along the first 10 m, only CWD > 30.0 cm diameter was recorded; along the second 10 m, all CWD > 7.0 cm diameter was recorded, and along the final 10 m, all CWD > 7.0 cm was

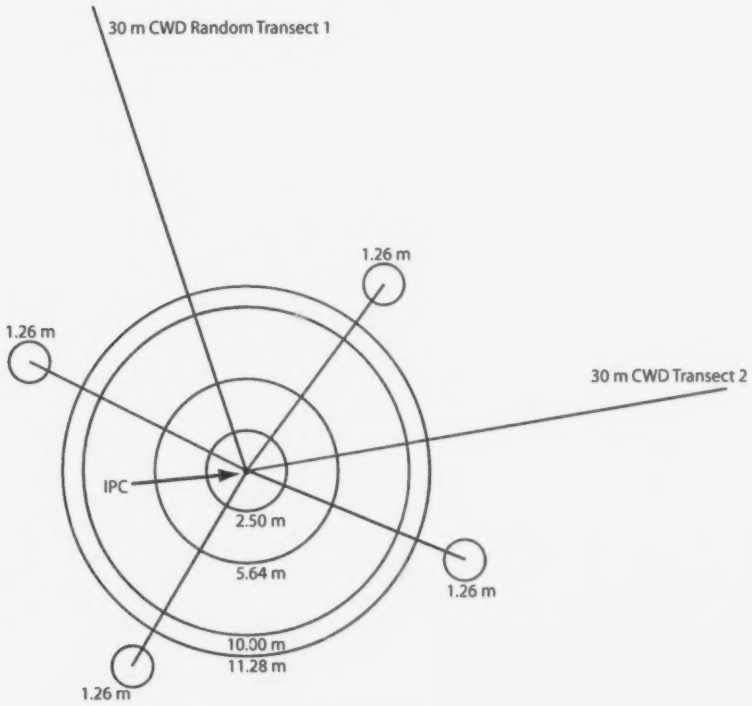


FIGURE 2 *Layout of sampling plots as adapted from the CMI procedures.*

recorded, along with a dot tally of SWD > 1.1 cm. The dot tally was combined into three categories for SWD: 1.1–3.0 cm, 3.1–5.0 cm, and 5.1–7.0 cm, and an average decay class across all categories was recorded. Using the two CWD transects, four micro-plots, one at 6 m and 12 m, on each transect, were established to measure FWD (< 1.1 cm diameter). Each micro-plot had a radius of 0.399 m (0.5 m^2), and FWD was collected to be weighed in the laboratory.

Two types of plots were established to monitor changes in composition and abundance of vegetation. It was determined during initial measurements in 2005 that a 30 × 30 m plot centred on the integrated plot centre was the appropriate size to record at least 95% of the total species in the immediate plot area. This ensured adequate detection of rarer plant species. The second type of plot was established to measure percent cover changes of common species. Four 1.26 m radius (0.002 ha) plots, as previously described for the regeneration assessment (Figure 2), were used to measure percent cover in order to monitor changes over time.

3.5 Measurements and records

Initial measurements were conducted during the field seasons of 2005 and 2006. Both types of vegetation plots were resurveyed during the field season of 2006 in burned unharvested plots established in 2005 in order to monitor annual changes in species composition. Remeasurements of all live trees ≤ 10.0 m in plots completed in 2005 was done in the fall of 2006 and 2007 to aid in determination of growth release. Subsequent measurements are scheduled for 2008, 2009, 2010, and in 5-year increments thereafter (assuming that funding is available). Copies of all field cards used during sampling are included in Appendix 2.

3.5.1 Site and soil description Standard data were collected on the ecosystem field form (FS882) (Appendix 2) using the procedures outlined by the Field Manual for Describing Terrestrial Ecosystems (B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests 1998) to characterize site and soil conditions for each plot installation. Soil pits were located outside of the 11.28 m radius plots.

3.5.2 Photography When an azimuth was not predetermined, all photographs were taken with the camera body pointed north. At each installation, eight plot photographs and five hemispherical canopy photographs were taken to represent plot conditions at the time of sampling.

3.5.2.1 ***Plot photographs*** Eight plot pictures were taken following the format outlined in the CMI procedures. Plot picture one was a close-up of the Integrated Plot Centre pin; it was taken standing above the pin, with a standard-sized object placed in the frame for scale and a sheet of paper indicating the plot number. Both plot pictures two and three were taken while standing over the IPC pin, holding the camera in a vertical position and shooting along CWD transects 1 and 2, respectively, capturing the vegetation and stand structure along the transect lines. The fourth and fifth pictures were taken at the end of CWD Transects 1 and 2, respectively, shooting towards the IPC pin, capturing the vegetation and stand structure along the transect line. Plot picture six was taken to represent the vegetation in the plot. Picture seven was taken standing above the IPC pin, holding the camera in a horizontal position, with arms raised above the head to capture the forest

canopy. Picture eight was taken while standing over the soil pit, with a standard-sized object placed in the frame for scale.

3.5.2.2 ***Hemispherical canopy photographs*** Five hemispherical canopy photographs were taken using a digital camera with a fisheye lens. The camera was mounted on a tripod adjusted to ensure that the lens was 1.3 m above ground level with the camera body orientated north. Four pictures were taken with the tripod placed in the centre of each 1.26-m vegetation plot; the fifth picture was centred over the IPC pin.

3.5.3 **Tree measurements** Within the main 11.28-m plot, species, diameter at breast height (dbh) (1.3 m), percent live crown, and wildlife tree type (WTT) (according to Keisker 2000) (Table 2) was recorded for all live and dead trees > 7.5 cm dbh. All trees were tagged with a numbered aluminum or plastic tag. Aluminum nails were used for live trees (to reduce infection probability) and steel nails were used for snags (aluminum nails bend too easily). Top heights were recorded for each tree, and for those live trees < 10 m in height, the uppermost four whorl heights. The whorl heights were used to estimate the last 4 years' height growth increments. A sonar range finder was used for these height measurements. For dead trees, branch order was recorded as per Storaunet (2004) (Table 3). In addition, a code was assigned to each snag estimating the cause of mortality; for MPB-killed trees, existing codes were recorded (Appendix 3). Tree cores were extracted at 1.3 m height on any dominant live trees to determine age of the stand. In addition, 10 cores were extracted from randomly selected dead dominant pines within each plot for determination of time since death (see section 3.5). For live advanced regeneration (≥ 30 cm height and ≤ 7.5 cm dbh), height, dbh, and the uppermost four whorl heights were recorded within the 5.64 m radius plot. The whorl heights were used to estimate the last 4 years' height growth increments. For dead advanced regeneration, only height and dbh were recorded. For small seedlings (< 30 cm height), height (rounded to the nearest cm), and substrate of establishment (i.e., rotting wood, mineral soil, humus) were recorded within the four 1.26 m radius plots. Substrate type by proportion of plot was also tallied and each seedling marked with a small-diameter metal pin. All

TABLE 2 *Classification of snag function as habitat for wildlife using (WTT) coding system (adapted from Keisker 2000)*

Wildlife tree type code	Distinguishing features
WTT-1	Hard outer wood surrounding decay-softened inner wood
WTT-2	Outer and inner wood softened by decay
WTT-3	Small, excavated or natural cavities
WTT-4	Large, excavated or natural cavities
WTT-5	Very large natural cavities and hollow trees
WTT-6	Cracks, loose bark, or deeply furrowed bark
WTT-7	Witch's brooms
WTT-8	Large branches, multiple leaders, or large-diameter broken tops
WTT-9	Arthropods in wood or under bark
WTT-10	Open-structured trees in or adjacent to open areas

TABLE 3 *Branch order classification (adapted from Storaunet 2004)*

Branch order	Description
5	Dead needles still attached
4	Few or no needles, but finest branches (i.e., with needle attachment stubs) abundant
3	Few or no fine branches, but 3rd-order branches (i.e., main branch divides and then divides again) abundant
2	Few 3rd-order branches but 2nd-order branches abundant
1	Only main branches or stubs of main branches present on the trunk of the tree

live tree information was coded consistent with VRI standards (B.C. Ministry of Sustainable Resource Management 2002).

3.5.4 CWD measurements All logs that intersected the transects were assessed for species (if possible), diameter at breast height (dbh in cm), diameter at point of intersection, attachment of primary branches (three classes: firm, loose, absent), fine branch flexibility (three classes: pliable, brittle, absent), bark presence (three classes: present, variable, absent), and bark attachment (four classes: firm, variable, loose, absent). The decay class of each log was also classified based on sapwood and heartwood condition and log structural integrity (Storaunet and Rolstad 2002; Newbery et al. 2004) (Table 4) and the classification outlined in the CMI procedures. Since the stage of decomposition varies in different parts of logs, an average decay class from the section of the log closest to the roots was used. The configuration of each log was assessed for potential use by wildlife, and categorized into six different habitat function types (Keisker 2000; Table 5). The six types are not mutually exclusive, meaning that a single log can function as multiple types of habitat. Bearing of each transect and distance on transect of each piece was recorded so that additional CWD can be recorded in subsequent years. Additional CWD information (e.g., rate of accumulation or fall rate) will be available from trees that enter the CWD pool from our tree sample plots

TABLE 4 *Log decay classes based on structural integrity and soundness of sapwood and heartwood*

Decay class	Characteristics
1	Solid log with sound sapwood and heartwood
2	Structurally sound log with preliminary signs of sapwood decay
3	Round log with structural integrity that supports its weight. Part of the sapwood in advanced stages of decay.
4	Log resting on the ground, unable to support its own weight due to heartwood decay
5	Log incorporating into the forest floor with the roots of coniferous and deciduous vegetation ramified throughout the sapwood and heartwood

TABLE 5 *Classification of log function as habitat for wildlife in the Sub-Boreal Spruce biogeoclimatic zone of British Columbia (after Keisker 2000)*

Function type	Attributes
1	Large, concealed spaces
2	Small, concealed spaces (or soft substrate allowing excavation of such spaces) at or below ground level and beneath hard material
3	Small, concealed spaces above ground level
4	Long, concealed spaces (or soft substrate allowing construction of runways)
5	Large or elevated, long material clear of dense vegetation
6	Invertebrates in wood, under bark, or in moss, litter, or humus accumulated on and around CWD

(recorded as down in future sampling period). Tree tag number will be recorded in subsequent remeasurement if any plot trees fall and intersect the transects.

3.5.5 Vegetation measurements In the large 30 × 30 m square plots, a list of all vascular and non-vascular species growing on humus substrate was created. In addition, an ocular estimate of cover was assessed for each tree and shrub species on the ecosystem field form (FS882) (Appendix 2) using the procedures outlined by the Field Manual for Describing Terrestrial Ecosystems (B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests 1998). Within the four smaller 1.26 m radius plots, an ocular cover estimate was recorded for each vascular and non-vascular species within the plot. Data were coded on the vegetation field form (Appendix 2). Species names were coded using the first four and three letters of the genus and species, respectively, of scientific name (e.g., CORNCAN for *Cornus canadensis*).

3.5.6 Dendrochronology measurements Cores collected from dead pine (see section 3.5.3) were frozen after sampling to prevent further decomposition (Herman et al. 1972). Approximately 100 cores were processed using standard dendrochronological techniques (Stokes and Smiley 1968) in 2005–06, and 400 more were processed in 2006–07. Ring-width series were measured using a Velmex measuring bench and WinDendro scanning system, by the University of Northern British Columbia dendrochronology processing laboratory.

Cores were prepared following standard denrochronological methods (Stokes and Smiley 1968). Each core was visually cross-dated. Ring-width series were measured to the nearest 0.01 mm using a Velmex bench, and the ring-width series were statistically cross-dated using the program COFECHA (Holmes 1986). All cores had their year of death estimated. This was done by statistically cross-dating their ring-width series to the master ring-width chronologies to assign a calendar year to the outer-most ring on the wood sample, thus determining year of tree death.

3.6 Quality control

To ensure that sampling was completed carefully and correctly, field teams were thoroughly trained on procedures. At least one member of the team was capable of supervising less experienced members to ensure a high degree of accuracy. Field measurements were conducted at a predefined level of precision. Bias was eliminated by using CMI procedures, as these processes are statistically valid and avoid rounding and vague definitions.

4 RECORDS

Research information and data generated by this project will be catalogued and linked with existing project data and products in the Ministry of Forests and Range Forest Science Program research database. Metadata tags for these projects and associated products will then be generated and uploaded to the Natural Resources Information Network database on an annual basis. The Research Branch has developed the methods and protocols for an efficient process. This will ensure that products resulting from British Columbia Forest Science Program investments are made known to as broad an audience as possible.

Digital map files (shapefiles) have been submitted to the Land and Resource Data Warehouse (LRDW), which is a central, consolidated repository of land and resource information from across the province. The Integrated Land Management Bureau manages the data warehouse. The data are available to government ministries and other agencies, business partners, and the public. The LRDW allows users to browse, search, query, view, access, analyze, order, pay for, and download datasets from the warehouse.

Currently, there are four main datasets generated for this project: (1) stand structure, (2) woody debris, (3) vegetation, and (4) dendrochronology. All data collected to date have been entered into Excel, and variables are described using the comment field in Excel. Data collected in 2006 utilized a double entry technique to eliminate data entry errors. Original field cards are stored at the Northern Interior Forest Region office and the contractor is using copies. Digital files are stored on the Ministry of Forests and Range centralized government server for the Northern Interior Forest Region. These data are backed up and stored offsite at the end of every workday. This will ensure that the British Columbia Forest Science Program investment will be protected and will be accessible following a catastrophic event.

Tree-ring chronologies will be submitted to the International Tree-Ring Data Bank (ITRDB) at the World Data Center for Paleoclimatology, according to the data standards listed at www.ngdcnoaagov/paleo/text/tringguide.html. One of the premier paleoclimatic databases in the world, the ITRDB contains measurements and tree-ring chronologies from over 1500 sites around the world, from over 100 tree species. Currently, British Columbia is under-represented in the databank; our new chronologies will be an important addition to the 43 existing chronologies from British Columbia.

5 MAINTENANCE SCHEDULE

Plot measurements and maintenance were conducted annually for the three years that funding had been confirmed (2005, 2006, and 2007). Following this time period, maintenance and monitoring will continue on an ad hoc basis, as funding and staff time are available. Source of funding for regular (approximately 5 year) re-sampling will be vigorously pursued. Licensees have been notified of the study activities, and agreements are in place to retain the plots as reserves at least for one full rotation (circa 80 years).

6 END RESULTS

The main end result of this project will be an improved understanding of ecological changes associated with MPB mortality. Data from this project will be used to refine stand-level tree growth and deadwood models. Habitat change data may also contribute to wildlife habitat studies. The randomly selected set of protected reserves provides an opportunity for other stand-level research.

B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests. 1998. Field manual for describing terrestrial ecosystems. srmwww.gov.bc.ca/risc/pubs/teecolo/ fmdte/deif.htm (Accessed Nov. 2005).

B.C. Ministry of Forests. 2003. Timber supply and the mountain pine beetle infestation in British Columbia. B.C. Min. For., For. Analysis Br., Victoria, B.C. www.for.gov.bc.ca/hts/pubs/beetledoc_oct29LO.pdf (Accessed Dec. 2006).

B.C. Ministry of Sustainable Resource Management. 2002. Standard and Procedures for Integration of Terrestrial Ecosystem Mapping (TEM) and Vegetation Resources Inventory (VRI) in British Columbia. ilmbwww.gov.bc.ca/risc/pubs/teveg/tem-vri-integration/tem-vri-integration-02.pdf (Accessed Dec. 2005).

DeLong, S.C., S.A. Fall, and G.D. Sutherland. 2004. Estimating the impacts of harvest distribution on road building and snag abundance. Can. J. For. Res. 34: 323–331.

DeLong, S.C., D. Tanner, and M.J. Jull. 1993. A field guide for site identification and interpretation for the southwest portion of the Prince George Forest Region. B.C. Min. For., Res. Br.,Victoria, B.C. Land Manag. Handb. 24. www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh24.htm

Fleming, R.A. 1999. Statistical advantages in, and characteristics of, data from long-term research. For. Chron. 75(3): 487–490.

Franklin, J.F. 1989. Importance and justification of long-term studies in ecology. In: Long-term studies in ecology: Approaches and alternatives. G.E. Likens (editor). Springer-Verlag, New York, N.Y., pp. 3–19.

Herman, F.R., C.E. Smith, and J.E. Firth. 1972. Ring count of decayed wood made easier through freezing. J. For. 70: 743.

Holmes, R.L. 1986. Quality control of cross-dating and measuring: a user's manual for program COFECHA. In: Tree-ring chronologies of western North America: California, eastern Oregon and northern Great Basin. R.L. Homes, R.K. Adams, and H.C. Fritts (editors). Univ. Arizona Press, Tucson, Ariz., pp. 44–49.

Keisker, D.G. 2000. Types of wildlife trees and coarse woody debris required by wildlife of north-central British Columbia. B.C. Min. For. Res. Br., Victoria, B.C. Work. Pap. 50: www.for.gov.bc.ca/hfd/pubs/Docs/Wp/Wp50.htm (Accessed Mar. 2008).

MacKillop, D. and R.F. Holt. 2004. The effects of mountain pine beetles (*Dendroctonus ponderosae*) on old-growth stand dynamics in the Moist Interior Plateau, Vanderhoof Forest District. Draft report to B.C. Min. For., Northern Interior Forest Region, Prince George, B.C.

Meidinger, D. and J. Pojar (editors). 1991. Ecosystems of British Columbia. B.C. Min. For., Victoria, B.C. Special Rep. Series 6: www.for.gov.bc.ca/hfd/pubs/Docs/Srs/Srs06.htm

Newbery, J.E., K.J. Lewis, and M.B. Walters, 2004. Estimating time since death of *Picea glauca* x *P. engelmannii* and *Abies lasiocarpa* in wet-cool sub-boreal spruce forests. Can. J. For. Res. 34: 931–938.

Pickett, S.T.A. 1989. Space-for-time substitution as an alternative to long-term studies. In: Long-term studies in ecology: Approaches and alternatives. G.E. Likens (editor). Springer-Verlag, New York, N.Y., pp. 110–135.

Stokes, M.A. and T.L. Smiley. 1968. An introduction to tree-ring dating. Univ. Chicago Press, Chicago, Ill.

Storaunet, K.O. 2004. Models to predict time since death of *Picea abies* snags. Scandinavian J. For. Res. 19:250–260.

Storaunet, K.O. and J. Rolstad, 2002. Time since death and fall of Norway spruce logs in old-growth and selectively cut boreal forest. Can. J. For. Res. 32: 1801–1812.

Wildlife Tree Committee of British Columbia. 2005. Wildlife/Danger Tree assessor's course workbook: Forest harvesting and silviculture course module. www.for.gov.bc.ca/hfp/training/00016/2005WDTAC.harvsilv-Ch%201,%202.pdf (Accessed Mar. 2008).

Plot number	UTM Co-ordinates	Northing	Easting	Type	Site series	Access
1	10 U	5939865.3	367802.0	Fire	SBSdk/01	Turn L on Rum Cache Rd at 164.5 km on Holy Cross Rd; go 1.8 km to turnoff on R; go 0.3 km on road to PA01 on L; go 400 m at 276 deg tp oc
2	10 U	5937836.9	369124.7	Fire	SBSdk/01	At 29 km on 500 Rd
3	10 U	5938249.5	369623.8	Fire	SBSdk/01	Go 1.7 km past Kenney Dam on 500 Rd to 28.3 km, turn off on R; tp 32 m from turnoff on R
4	10 U	5939192.9	370107.8	Fire	SBSdk/01	At Kluskus-Natalkus junction (approx 27 km on 500 Rd); turn L on Holy Cross Rd, go to 165.9 km to landing (LND) on L
5	10 U	5936039.8	363937.4	Matrix	SBSdk/01	At 34.4 km on 500 Rd turn L; go 300 m to landing on R; go 40 m at 236 deg to tp
6	10 U	5934813.2	370456.4	Matrix	SBSdk/01	Quad required; 535.8 km turn L on 611 Rd; at 10.5 km on 611 Rd turn L on cutblock road; go 1.5 km to block edge; Quad from here 2.1 km to tp 6
7	10 U	5953055.2	455593.1	Matrix	SBSdw3/01	At 45.3 km on Bobtail Rd turn R; 5.4 km from turnoff to junction; turn L at junction and go 2.8 km to LND on R
7a	10 U	5953281.0	454103.0	Buffer	SBSdw3/01	**At 37.5 km on Bobtail Rd - 400 Rd is now changed to Bobtail Rd and 'old' Bobtail is now Grizzly Rd**. Go 37.5 km on Bobtail Rd, turn L onto Grizzly Rd; go 8.3 km on Grizzly Rd, turn R; go 5.4 km from turnoff to junction; turn L at junction; then go 2.8 km to landing on R. Follow ribbon into plot 59 then 7a.
8	10 U	5954527.6	459520.1	Matrix	SBSdw3/01	At 8.3 km on Grizzly Rd
9	10 U	5962222.6	453464.5	Matrix	SBSdw3/01	At 33.5 km on Bobtail Rd turn R; at 300 m turn L on Blackwater Rd; go 1.3 km to end of road; go 50 m at 90 deg to tp, 2007 Access Updates – go 107 m at 263 deg to PC.
10	10 U	5927396.2	407807.8	Matrix	SBSdk/01	Go on the Gold Rd, turn R onto Gold 5000 Rd, 2007 Access Updates - Gold Road = Kluskus-Lavoie and 5000 Rd not marked=has stop sign=turn R at 138 km off Gold Rd onto 5000 Rd and go to Y in road at 3.9 km and stay left, and tp is at 700 m past turn on L, then go 675 m at 109 deg to PC
11	10 U	6000811.0	381008.0	Buffer	SBSdw3/01	On Trout Rd go R; 12.4 km on 1200 Rd. 1200 Rd at 3.1 km go R on 1203 Rd. 2.8 km go R.
12	10 U	5966921.2	379382.9	Matrix	SBSdk/01	At 131 km on Holy Cross Rd; park in the gravel pit and take the Cabin Creek Trail

Plot number	UTM Co-ordinates	Northing	Easting	Type	Site series	Access
13	10 U	5944969.3	383045.4	Buffer	SBSdk/01	23 km North of Nechako Lodge; 3.7 km N of Cutoff Creek Rec Site; turn L on Swanson FSR (going to Lodge); at 4.4 km is junction to R- stay L; at 6.3 km turn R on Hat Lk Rd; at 7.5 km turn R at junction; tp at 9.9 km on R
15	10 U	5950716.8	463598.5	Matrix	SBSdw3/01	33.5 km Bobtail Rd turn L on Telegraph Trail Rd, at 17.6 km Telegraph Trail Rd turn L. Go 1.2 km to landing and tp
16	10 U	5951215.1	457536.0	Buffer	SBSdw3/01	At 12.8 km off Grizzly Rd turn R onto Berta Rd; go 0.5 km turn R; go 1.8 km turn R; 300 m to tp
17	10 U	5951667.5	461003.0	Buffer	SBSdw3/01	At 11.7 km on Grizzly Rd; 0.5 km from Bobtail Lk; 1.2 km from Eutalazella Lk Rd
18	10 U	5952272.4	459714.5	Buffer	SBSdw3/01	At 11.3 km on the Grizzly FSR on R; follow skidtrail 700m
19	10 U	5935483.0	353693.0	Buffer	SBSdk/01	At approx 44 km on 500 Rd, turn R on Kluskus-Stephen Rd; go 7.9 km to landing on R; tp on R 2007 Access Updates -on 86 Rd go to 3.17 km see pink ribbon and go into bush and along ridge trail to gap at top and then down hill at 80 deg between the two swamps. When you can see the swamp on R- should see blue ribbon in tree- then cross stream and cut back up to cc on right and go approx 240 m to tp on L and then go 535 m at 83 deg to pc
20	10 U	5924422.0	397229.0	Buffer	SBSmc3/01	Turn R at 86 km on Kluskus Rd heading S (86 Rd). Go 3.2 km on 86 Rd to creek deactivation. Go 530 m from creek crossing east along cutblock to tp
21	10 U	5930136.0	387556.0	Buffer	SBSmc3/01	Turn L at 6 km on Red Rd onto Red 2000 Rd, go 3-4 km to tp on L
22	10 U	5935169.0	366129.0	Buffer	SBSdk/01	Turn L at 29.9 km on 500 Rd
23	10 U	5915629.0	378150.0	Buffer	SBSdk/01	At 35.1 km on Red Rd turn R on road thru block, go 400 m to parking
24	10 U	5909063.0	404275.0	Buffer	SBSmc3/01	On Blue Rd (turn off Kluskus Rd approx at 99 km- at junction turn L); at 6.5 km, across from Tanli Lk FSR turn L; go 1 km to log across road, walk approx 500 m along road, tp on R 2007 Access Updates - stay R at 0.4 m junction and go 700 m to deactivation/culvert out and then around corner approx 200 m on R to tp. Then go 90 m at 122 deg to pc
25	10 U	5923513.0	398858.0	Buffer	SBSmc3/01	At 88.2 km on Kluskus Rd turn L; 0.3 km on 88 Rd to tp near end of gravel pit on R
26	10 U	5924868.0	398651.0	Buffer	SBSmc3/01	At 87.3 km on Kluskus Rd. Turn off on old road on L, tp near creek 2007 Access Updates - go 116 m at 100 deg from tp to pc

Plot number	UTM Co-ordinates	Northing	Easting	Type	Site series	Access
27	10 U	5937936.0	374870.0		Pine Lichen	At 22 km on 500 Rd turn L on 5600 Rd, go 250 m to tp on L 2007 Access Updates - go 88 m at 277 deg to pc from tp
28	10 U	5930454.0	396182.0		Pine Lichen	At 80 km on Kluskus Rd; LND on R; tp on R 2007 Access Updates - go 95 m at 264 deg from tp to pc
29	10 U	5895597.0	364504.0	Matrix	SBSmc3/01	At Kluskus Rd 145.3 km turn L, tp at switchback at 0.4 km - go 104 m at 104 deg from tp to pc
34	10 U	5897940.5	424937.0		Pine Lichen	99.5 km on Kluskus Rd = Blue Rd. Then 19.1 km on Blue Rd = Blue 4000 Rd. Go 13.8 km on Blue 4000 Rd to ACP. Go 8.74 km from ACP to Block Rd; junction on R. Go 380 m from cutblock edge; then go 440 m at 162' from cutblock to tp.
35	10 U	5889908.6	407987.3	Matrix	SBSmc3/01	Go to 25.4 km on Blue Rd; Turn L on Blue 7000 Rd; 5.2 km stay L; 5.6 km stay L; 6.6 km take middle road; go approx 1.5 km to tp (approx 8.1 km on Blue 7000 Rd) 2007 Access Updates - at 6.4 km stay R and then bear L for 1.5 km = tp at 8 km
36	10 U	5887755.1	391184.5	Matrix	SBSmc3/01	43.2 km off Blue Rd turn L; go 1 km and park. tp on R at L of landing. - go 205 m at 212 deg to pc
37	10 U	5888881.4	349987.8		Pine Lichen	At 142 km on Kluskus Rd, turn R onto Maluput Rd. Go 17.5 km; turn L on CP224-3. At 1.7 km stay R. At 1.9 km stay R. At 3.1 km park vehicle. Walk ~ 100 m on skidtrail to tp.
38	10 U	5885993.4	348403.5	Matrix	SBSmc3/01	At 159.3 km on Kluskus Rd turn R onto Green 7000 Rd. At 6.3 km Green 7000 Rd = Gate = (need gate key). Plot at 11.9 km on Green 7000 Rd.
40	10 U	5887036.8	354272.3		Pine Lichen	Kluskus Rd turn R 156 km; go 0.8 km turn L on Kluskus-Vigano Rd; go 3.7 km to skidtrail to tp 40; take second L; two junctions close together on Kluskus-Vigano (Vigano junction) 3.7 km from pc 2007 Access Updates - at 200 m from bridge, take skidtrail for approx 550 m to new tp on right. Then go 120 m at 306 deg to pc
41	10 U	5940705.0	374038.4	Fire	SBSdk/01	Take Fish Lake Rd east off of Kenny Dam Rd approx 2.5 km N of Kenny Dam. Go approx 1.2 km to tp on L
42	10 U	5943545.3	370983.6	Fire	SBSdk/01	At 161 km on Holy Cross Rd, tp on west side of road
43	10 U	5948751.5	373331.9	Fire	SBSdk/01	152.5 km on Holy Cross Rd take jctn to R. Go approx. 2.2 km. tp on R. Go S for ~ 200 m from tp

Plot number	UTM Co-ordinates	Northing	Easting	Type	Site series	Access
44	10 U	5942433.1	373768.6	Fire	SBSdk/01	Tp approx 5 km north of Kenney Dam on Kenny Dam Rd, plot is 120 m at 371 deg from logging road on R (past tp)
45	10 U	5943427.1	373980.8	Fire	SBSdk/01	Tp approx 6 km N of Kenny Dam on Kenny Dam Rd. tp at R
46	10 U	5946466.0	380005.0	Fire	SBSdk/01	11.7 km north of Kenney Dam go R on Nawgeetuk Road (from dam); go 4.5 km to turnoff on R. tp at junction
47	10 U	5932456.5	392184.3		Pine Lichen	Go 1.8 km on Red Rd; turn R onto cutblock road and go 0.9 km to landing
48	10 U	5918004.7	369771.2		Pine Lichen	At 32.7 km on Red Rd turn R on 13000 Rd; Go 5.3 km to Access Control Point (ACP) (Stay R at junction 4.2 km); From ACP a Quad is required ; 400 m from ACP go R at junction; 3.2 km = POT Rd and tp
49	10 U	5917650.0	373745.0	Matrix	SBSdk/01	At 27 km on Red Rd turn R on 13000 Rd. At 1.6 km turn L onto 13200 Rd. At 1.9 km keep straight on road. At 3.8 km = POT of road and landing. **No tp from this location, however closer than original layout.
50	10 U	5915740.5	376459.3	Buffer	SBSdk/01	Turn R at 32.7 km on Red Rd onto 13000 Rd; go 0.5 km, turn L onto 13100 Rd; go 0.9 km to junction, stay R; go to co-ordinates- at 10 U E 0375495 N5916715 take trail to L for 1.36 km to tp
59	10 U	5953086.0	454442.0		Pine Lichen	Same as for 7a
60	10 U	5953261.0	452265.0	Matrix	SBSdw3/01	At 42.9 km on Bobtail Rd; turn L at junction at 5.5 km past junction with Grizzly Rd

Plot Header Card and Checklist

BEM Permanent Plots 2006 - Plot Header Card and Checklist

Plot # _____ Crew _____ Date _____ Page ____ of ____

Access Notes to Tie Point (starting from a permanent reference point (e.g., Bridge, Highway)):

	Yes	Inc	No
Access Notes			
Established			
Mensuration			
Site/Soil			
30x30 Veg			
1.26 Veg			
CWD			
FWD			
Snag Cores			
Live Core			
Fisheye Pic.			
Plot Pic.			

Tie Point GPS Location: N_____ E_____
Distance and Bearing to Plot Centre: _____ M @_____
Plot Centre GPS Location: N_____ E_____
Distance and Bearing from Reference Tree to Plot Centre:
_____M @_____

Cores:	Tree #						FWD # of Bags	
Live							Trans #1	Trans #2
Snag								

Fisheye Pictures:			Veg 1	Veg 2	Veg 3	Veg 4
Roll #						

Plot Pictures	1	2	3	4	5	6	7	8
Roll #:								

1) Close up of Plot Centre Pin
2) CWD Transect 1 (IPC out)
3) CWD Transect 2 (IPC out)
4) Reverse CWD Transect 1 (POT to IPC)
5) Reverse CWD Transect 2 (POT to IPC)
6) Represen. of Sample Veg
7) Forest Canopy Above IPC
8) Photo of Soil Profile
** Include a plaque with plot number in picture #1

Comments:

CWD Field Card

BEM Permanent Plots 2006 - CWD Field Card

Plot # _____ Date _____ Weather _____ Crew _____

Transect 1 Bearing: _____ Transect 2 Bearing: _____ Page _____ of _____

Transect #	Distance on Transect (m):	CWD ID#	Tree sp.	Diam. (cm)	Dia. Midpoint (cm)	Length (m)	% Decay Class 1 at transect	Tilt	CWD T	1	2	3	4	5	6	DC (1-6) Macer	DC (1-6) Daniels	Tree Position (1-2)	Proportion decay	Branch integrity (1-3)	Fine branch flex (1-3)	Bark class (1-3)	Bark integrity (1-4)	(S) Snag/ (W) windthrow	Comments (UTM)

Transect Layout: 0 - 10m measure >30cm; 10 - 20m measure > 7.0cm; 20 - 30m tally ≤ 7.0 cm (up to 2m ht.)

Transect 1 Tally:	1.1-3.0 cm	3.1-6.0 cm	6.1-7.0 cm	Ave Decay Class
Totals:				

Transect 2 Tally:	1.1-3.0 cm	3.1-6.0 cm	6.1-7.0 cm	Ave Decay Class
Totals:				

	FWD # of Bags
6m	
12m	

Forest Mensuration Live Tree Field Cards

BEM Permanent Plots 2006 - Forest Mensuration Live Tree Field Cards

Plot# _____ Beetle Code Yr Attack _____ Date _____ Weather _____ Crew _____ Page ___ of ___

Sector	Tree #	Tree sp.	Dia. (cm)	Total Ht(m)	Whorl Ht.1 (m)	Whorl Ht.2 (m)	Whorl Ht.3 (m)	Whorl Ht.4 (m)	Height to Live Crown (m):	CR Ratio	Crown Class	Core (last 10) (mm): Core 1	1	3	Int.	1	2	3	4	5	6	7	8	9	10	DC (1-9) Mase	Snap (T/M/B/N)	Scar	Fork	Broken Top (Est. Dia (cm))	Dead Top	Crook	Other (Comments)	Bark Code	Wood	Animal Activity	Lichen	Agent Mortality	Beetle Code 28

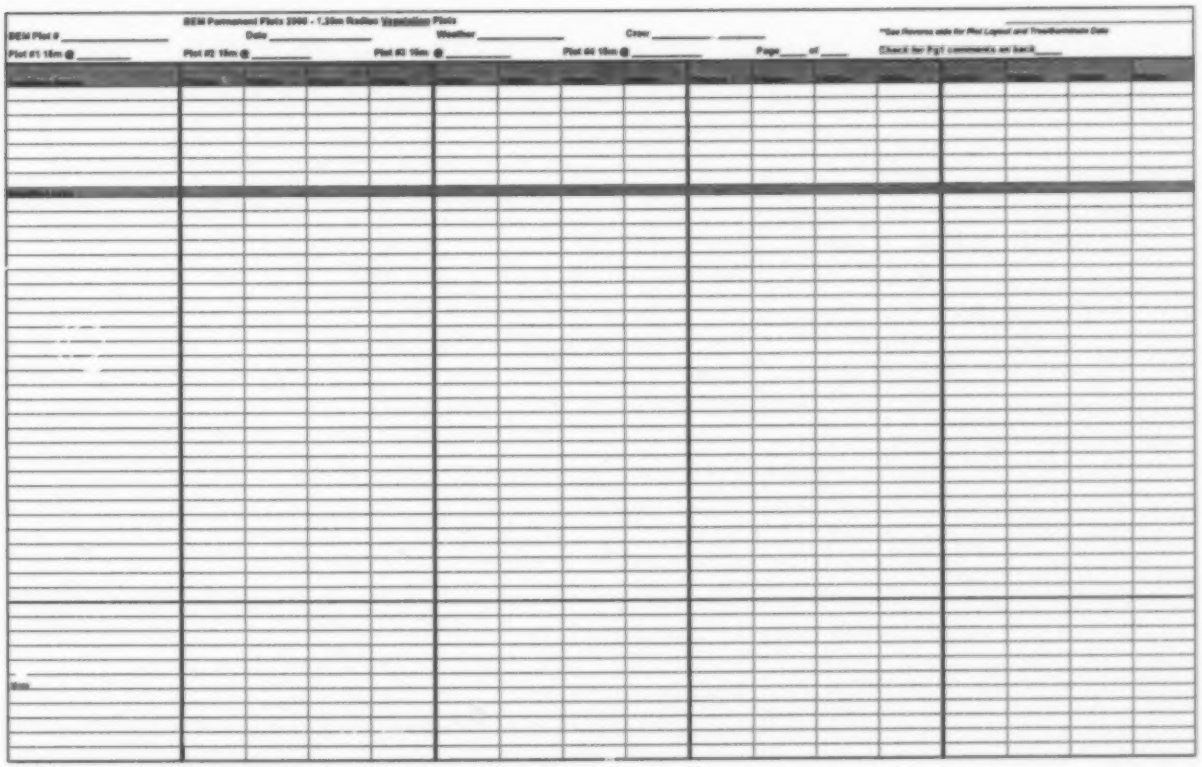
Forest Mensuration Snag Field Cards

BEM Permanent Plots 2006 - Forest Mensuration Snag Field Cards

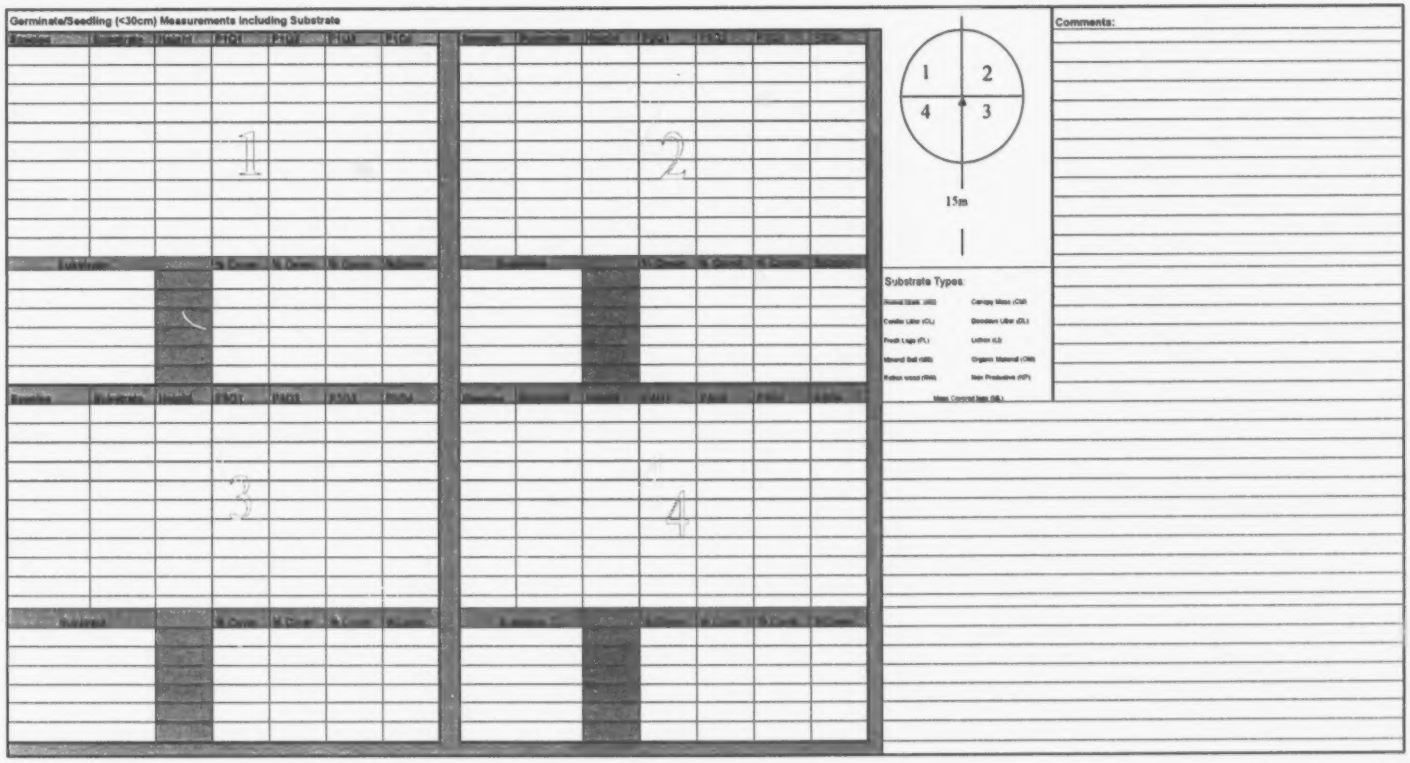
Plot# _____ Beetle Code Yr Attack _____ Date _____ Weather _____ Page ___ of ___ Crew _____

Sector	Tree #	Tree sp.	Dia. (cm)	Ht. (m)	Crown Class	1	2	3	1	2	3	4	5	6	7	8	9	10	DC (1-9) Master	DC (1-9) Daniels	Snag (TAMBIN)	Depth decay (cm)	Branch Integrity (1-3)	Fine branch flex (1-3)	Bark class (1-3)	Bark integrity (1-4)	Branch order present	Scar	Fork	Broken Top (Ext. Dia. (cm))	Dead Top	Crook	Other (Comments)	Bark Code	Wood Code	Animal Activity	Lichen	Agent Mortality	Beetle Sp.__

Vegetation Plot – 1.26 m radius (front side)


BEM Plot # _____
Plot #1 15m @ _____
BEM Permanent Plots 2000 - 1.26m Radius Vegetation Plots
Date _____
Weather _____
Crew _____ _____
Page____ of ____
Plot #2 15m @ _____
Plot #3 15m @ _____
Plot #4 15m @ _____
*See Reverse side for Plot Layout and Tree/Seedlings Data
Check for Pg1 comments on back____

Vegetation Plot – 1.26 m radius (back side)



FS882 (1) – Ecosystem Field Form Site Information (front side)

BRITISH COLUMBIA
MINISTRY OF FORESTS
BC ENVIRONMENT

ECOSYSTEM FIELD FORM

DATE Y M D	PLOT NO.
PROJECT ID.	FIELD NO. / SURVEYOR(S)

SITE DESCRIPTION

LOCATION

GENERAL LOCATION

FOREST REGION	MAPSHEET	UTM ZONE	LAT./ NORTH.	LONG./ EAST.

AIRPHOTO NO.	X CO-ORD.	Y CO-ORD.	MAP UNIT

SITE INFORMATION

PLOT REPRESENTING

BGC UNIT	SITE SERIES	TRANS./ DISTRIB.	ECOSECTION

MOISTURE REGIME	NUTRIENT REGIME	SUCCESS. STATUS	STRUCT. STAGE	REALM/ CLASS

ELEV. m.	SLOPE %	ASPECT °	MESO SLOPE POS.	SURFACE TOPOG.

NOTES

SITE DIAGRAM

SITE DISTURB.	PHOTO ROLL
EXPOS. TYPE	FRAME NOS.

SUBSTRATE (%)

ORG. MATTER		ROCKS	
DEC. WOOD		MINERAL SOIL	
BEDROCK		WATER	

FS882 (1) HRE 98/5

FS882 (2) – Ecosystem Field Form Soil Information

SOIL DESCRIPTION

GEOLOGY BEDROCK	C. F. LITH.	**SURVEYOR(S)**	**PLOT NO.**
TERRAIN TEXTURE 1 / 2	SURFICIAL MATERIAL 1 / 2	SURFACE EXPR. 1 / 2	GEOMORPH. PROCESS 1 / 2
SOIL CLASS.	**HUMUS FORM**	**HYDROGEO.**	
ROOTING DEPTH cm	ROOT RESTRICT. LAYER TYPE	WATER SOURCE	DRAINAGE
R. Z. PART. SIZE	DEPTH cm	SEEPAGE cm	FLOOD RG.

PROFILE DIAGRAM

ORGANIC HORIZONS/LAYERS

HOR/ LAYER	DEPTH	FABRIC STRUCTURE	FABRIC vPOST	MYCEL. AB.	FECAL AB.	ROOTS AB.	ROOTS SIZE	pH	COMMENTS (consistency, character, fauna, etc):

MINERAL HORIZONS/LAYERS

HOR/ LAYER	DEPTH	COLOUR	ASP.	TEXT.	% COARSE FRAGMENTS G	C	S	TOTAL	SHAPE	ROOTS AB.	ROOTS SIZE	STRUCTURE CLASS	STRUCTURE KIND	pH	COMMENTS (mottles, clay films, effervesc., etc):

NOTES:

FS882 (2) HRE 98/5

FS882 (3) – Ecosystem Field Form (30 x 30m Vegetation Plot)

VEGETATION

SPP. COMP. ☐ LIST PART. ☐ | % COVER BY LAYER: TREE (A) ☐ SHRUB (B) ☐ HERB (C) ☐ MOSS / LICHEN (D) ☐ | SURVEYOR(S) | PLOT NO. | PAGE OF

TREES	A1	A2	A3	A	B1	B2	B

SHRUBS	B1	B2	B

HERB LAYER (C)	%

MOSS / LICHEN / SEEDLING (D)	%

ADDITIONAL SPECIES	LAYER	%

NOTES: _____

FS882 (3) HRE 98/5

TABLE 1 *Mountain Pine Beetle Codes – (1- and 2-year Life Cycles)*

Code 1 Most-recent year of full-attack (200__)
Code 2 Most-recent year of strip-attack (200__)

With mountain pine beetle on a 1-year life cycle 90–95% of the time, attacks occur mainly in July and early August but may extend into September. With the 2-year cycle, the attack occurs in late August or early September. All "external bark" and "phloem/sapwood" indicators refer to successfully attacked portions of the tree. Full-attacks are on 50% or more of the tree's circumference; strip-attacks are on less than 50%. Crown symptoms refer to full-attacks.

		External Bark Indicators				Phloem/Sapwood Indicators									
Beetle Life Cycle	**Time of Survey**	**pitch tubes**	**boring dust**	**woodpecker damage**	**exit hole**	**parent adults**	**eggs**	**larvae**	**pupae**	**immature adults**	**sapwood**	**blue staining**	**fungi**	**secondary insects**	**Crown Symptoms**
1-year	Sept.–Nov.	– sticky	– powdery reddish-brown	– light to moderate	–	– alive	– maybe a few in Sept.	3–7 mm	–	–	– still moist	– light & shallow	–	– a few	– none
1-year	Dec.–April	– still pliable	– some left between bark scales	– moderate to heavy	–	– dying	–	5–7 mm	–	–	– drying	– moderate & deepening	–	– mostly predators	– none
1-year	May–June	– stiffening	– scarce	– heavy	–	– dead	–	– a few 5–7 mm	– many	– many	– dryer	– moderate & deepening	– maybe some	– predators & then secondary beetles	– chlorotic or red
2-year	Sept.–Nov.	– still pliable	– some left between bark scales	– usually very light	–	– alive	– none or some	–	–	–	– still moist	– light & shallow	–	–	– none
2-year	Dec.–April	– stiffening	– scarce	– light	–	– alive	– none or some	–	–	–	– still moist	– light & shallow	–	– mostly predators	– none
2-year	May–June	– stiff	–	– light	–	– dying	– none or some	3–5 mm	–	–	– drying	– light & shallow		– mostly predators	– none

TABLE 2 *Mountain Pine Beetle Codes – (1- and 2-year Life Cycles)*

Code 3 Second most-recent year of full-attack (200__)
Code 4 Second most-recent year of strip-attack (200__)

With mountain pine beetle on a 1-year life cycle 90–95% of the time, attacks occur mainly in July and early August but may extend into September. With the 2-year cycle, the attack occurs in late August or early September. All "external bark" and "phloem/sapwood" indicators refer to successfully attacked portions of the tree. Full-attacks are on 50% or more of the tree's circumference; strip-attacks are on less than 50%. Crown symptoms refer to full-attacks.

		External Bark Indicators				Phloem/Sapwood Indicators									
Beetle Life Cycle	**Time of Survey**	**pitch tubes**	**boring dust**	**woodpecker damage**	**exit hole**	**parent adults**	**eggs**	**larvae**	**pupae**	**immature adults**	**sapwood**	**blue staining**	**fungi**	**secondary insects**	**Crown Symptoms**
1-year	Sept.–Nov.	– stiffening	–	– very heavy	– many	– dead	–	–	–	–	– very dry with some checking	– heavy & deepening	– some	– predators & secondary beetles	– bright red
1-year	Dec.–April	– stiff	–	– very heavy	– many	– dead	–	–	–	–	– very dry with some checking	– heavy & deepening	– moderate	– predators & secondary beetles	– dull read to turning grey
1-year	May–June	– brittle	–	– very heavy	– many	– dead	–	–	–	–	– very dry with some checking	– heavy & deepening	– heavy	– predators & secondary beetles	– mostly grey
2-year	Sept.–Nov.	– stiffening	–	– light to moderate	–	– dead	–	5–7 mm	–	–	– dryer	– moderate & deepening	– some	– predators & secondary beetles	– none
2-year	Dec.–April	– stiff	–	– moderate	–	– dead	–	5–7 mm	–	–	– very dry with some checking	– heavy & deepening	– moderate	– predators & secondary beetles	– none
2-year	May–June	– brittle	–	– heavy	–	– dead	–	5–7 mm	– many	– many	– very dry with some checking	– heavy & deepening	– heavy	– predators & secondary beetles	– chlorotic or red

TABLE 3 *Mountain Pine Beetle Codes – (1- and 2-year Life Cycles)*

Code 5 Third most-recent year of full-attack (200__)
Code 6 Third most-recent year of strip-attack (200__)

With mountain pine beetle on a 1-year life cycle 90–95% of the time, attacks occur mainly in July and early August but may extend into September. With the 2-year cycle, the attack occurs in late August or early September. All "external bark" and "phloem/sapwood" indicators refer to successfully attacked portions of the tree. Full-attacks are on 50% or more of the tree's circumference; strip-attacks are on less than 50%. Crown symptoms refer to full-attacks.

		External Bark Indicators				Phloem/Sapwood Indicators									
Beetle Life Cycle	**Time of Survey**	**pitch tubes**	**boring dust**	**woodpecker damage**	**exit hole**	**parent adults**	**eggs**	**larvae**	**pupae**	**immature adults**	**sapwood**	**blue staining**	**fungi**	**secondary insects**	**Crown Symptoms**
1-year	Sept.–June	– brittle & yellow	–	– very heavy	– many	– dead	–	–	–	–	– very dry with more checking	– heavy & deepening	– variable	– ambrosia & woodborer holes	– grey (no needles left)
2-year	Sept.–Nov.	– brittle	–	– very heavy	– many	– dead	–	–	–	–	– very dry with some checking	– moderate & deepening	– variable	– ambrosia & woodborer holes	– chlorotic or red
2-year	Dec.–April	– brittle	–	– very heavy	– many	– dead	–	–	–	–	– very dry with some checking	– heavy & deepening	– variable	– ambrosia & woodborer holes	– dull red turning to grey
2-year	May–June	– brittle & yellow	–	– very heavy	– many	– dead	–	–	–	–	– very dry with some checking	– heavy & deepening	– variable	– ambrosia & woodborer holes	– grey